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Malloy et al.

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(54) **SYSTEMS AND COMPUTER PROGRAM PRODUCTS TO IDENTIFY RELATED DATA IN A MULTIDIMENSIONAL DATABASE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 531 days.

This patent is subject to a terminal disclaimer.

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(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 10/325,299, filed on Dec. 18, 2002, now Pat. No. 7,472,127.

(51) **Int. Cl.**
G06F 7/00 (2006.01)
G06F 17/30 (2006.01)

(52) **U.S. Cl.** **707/717**; 707/830; 707/957; 707/958; 707/E17.002; 707/E17.056

(58) **Field of Classification Search** 707/717, 707/830, 957, 958, E17.002, E17.056
See application file for complete search history.

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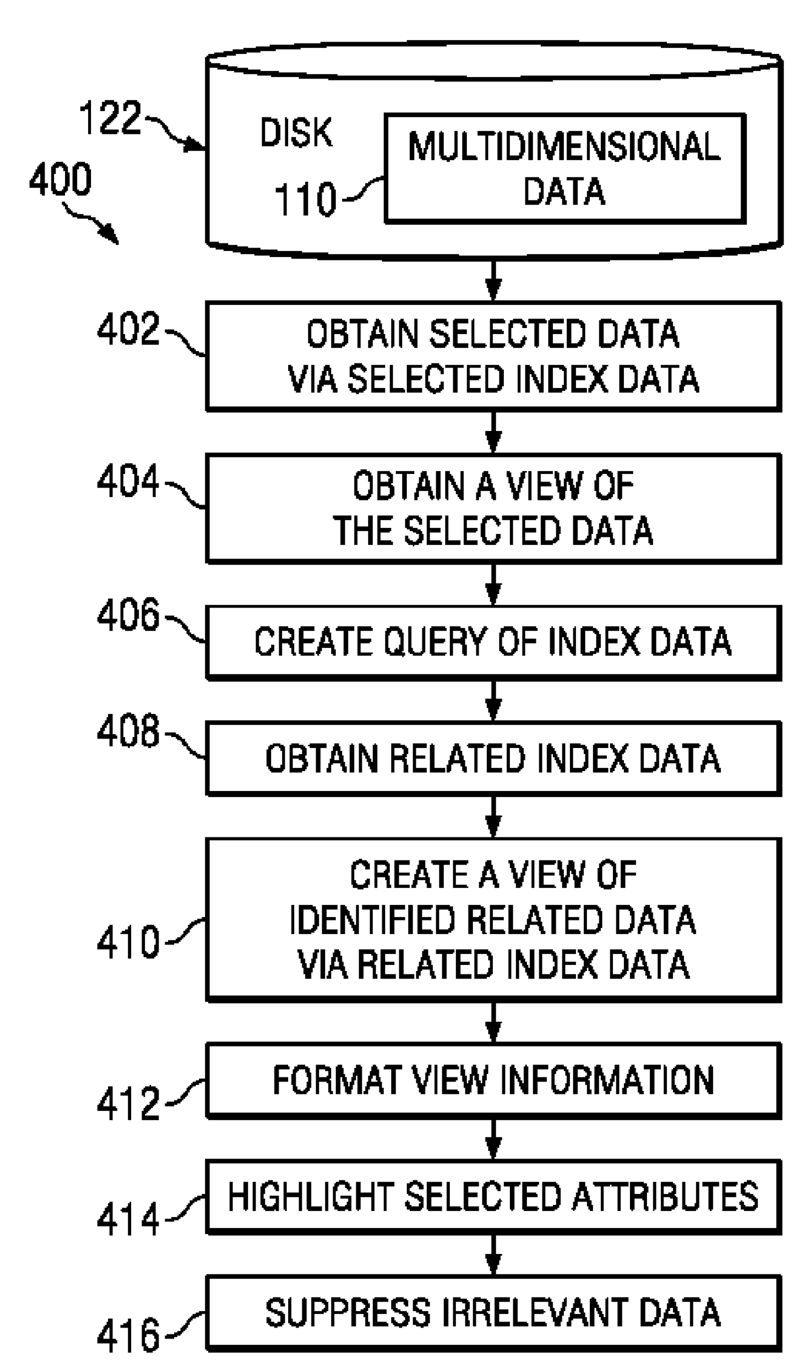
(57) **ABSTRACT**

Systems and computer program products that identify data that is related to and associated with data that has been selected from a multidimensional database. The overwhelming amount of data in a multidimensional database that may be viewed by a user, such as a data analyst, is reduced to the selected and associated data by use of index data and related index data, according to the present invention. The views of selected data and related data may be highlighted and formatted for presentation to the user. Further, irrelevant data is filtered out and not presented to the user. Existing systems have not been able to efficiently and adequately identify data that is related to and associated with selected data in a multidimensional database.

6 Claims, 4 Drawing Sheets



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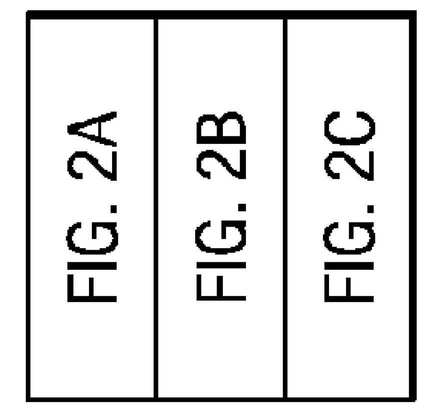
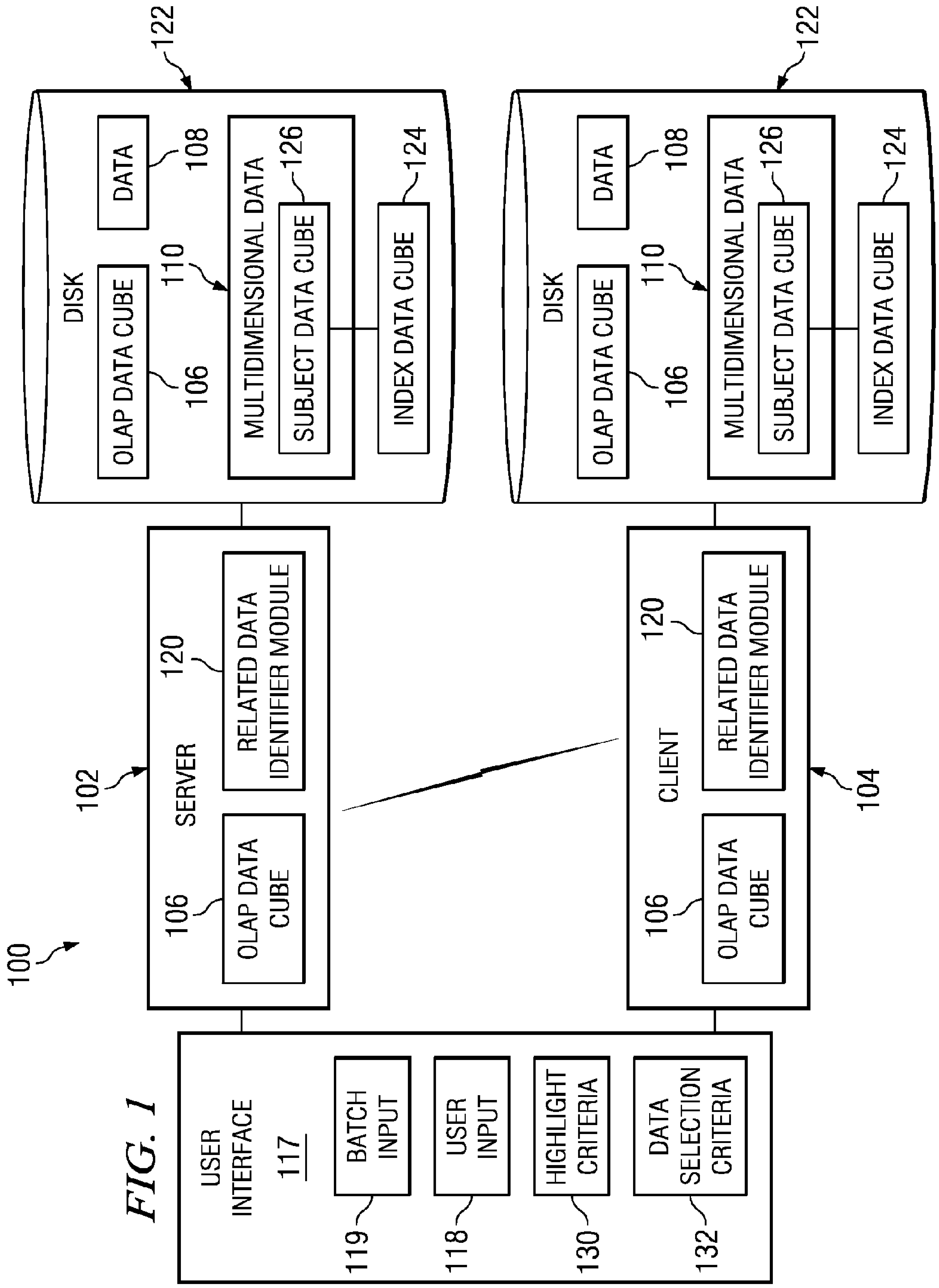


FIG. 2A
FIG. 2B
FIG. 2C

FIG. 2



100
SERVER
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OLAP DATA CUBE
106
RELATED DATA IDENTIFIER MODULE
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DISK
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OLAP DATA CUBE
106
DATA
108
MULTIDIMENSIONAL DATA
110
SUBJECT DATA CUBE
126
INDEX DATA CUBE
124
CLIENT
104
OLAP DATA CUBE
106
RELATED DATA IDENTIFIER MODULE
120
DISK
122
OLAP DATA CUBE
106
DATA
108
MULTIDIMENSIONAL DATA
110
SUBJECT DATA CUBE
126
INDEX DATA CUBE
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USER INPUT
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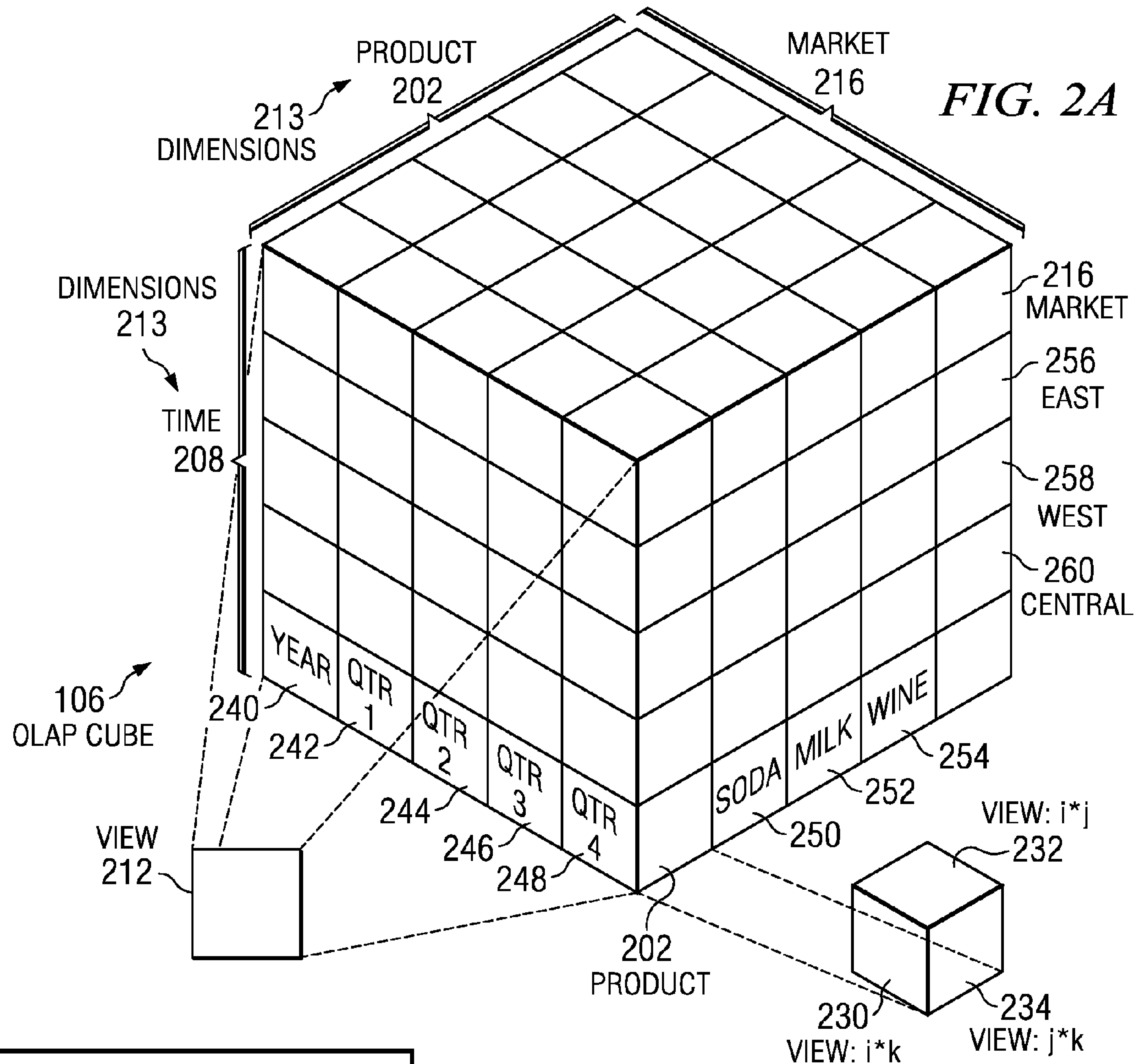
HIGHLIGHT CRITERIA
130
DATA SELECTION CRITERIA
132

FIG. 1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EAST
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CENTRAL
YEAR
QTR 1
QTR 2
QTR 3
QTR 4
SODA
MILK
WINE
106
OLAP CUBE
240
242
244
246
248
250
252
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VIEW
212
202
PRODUCT
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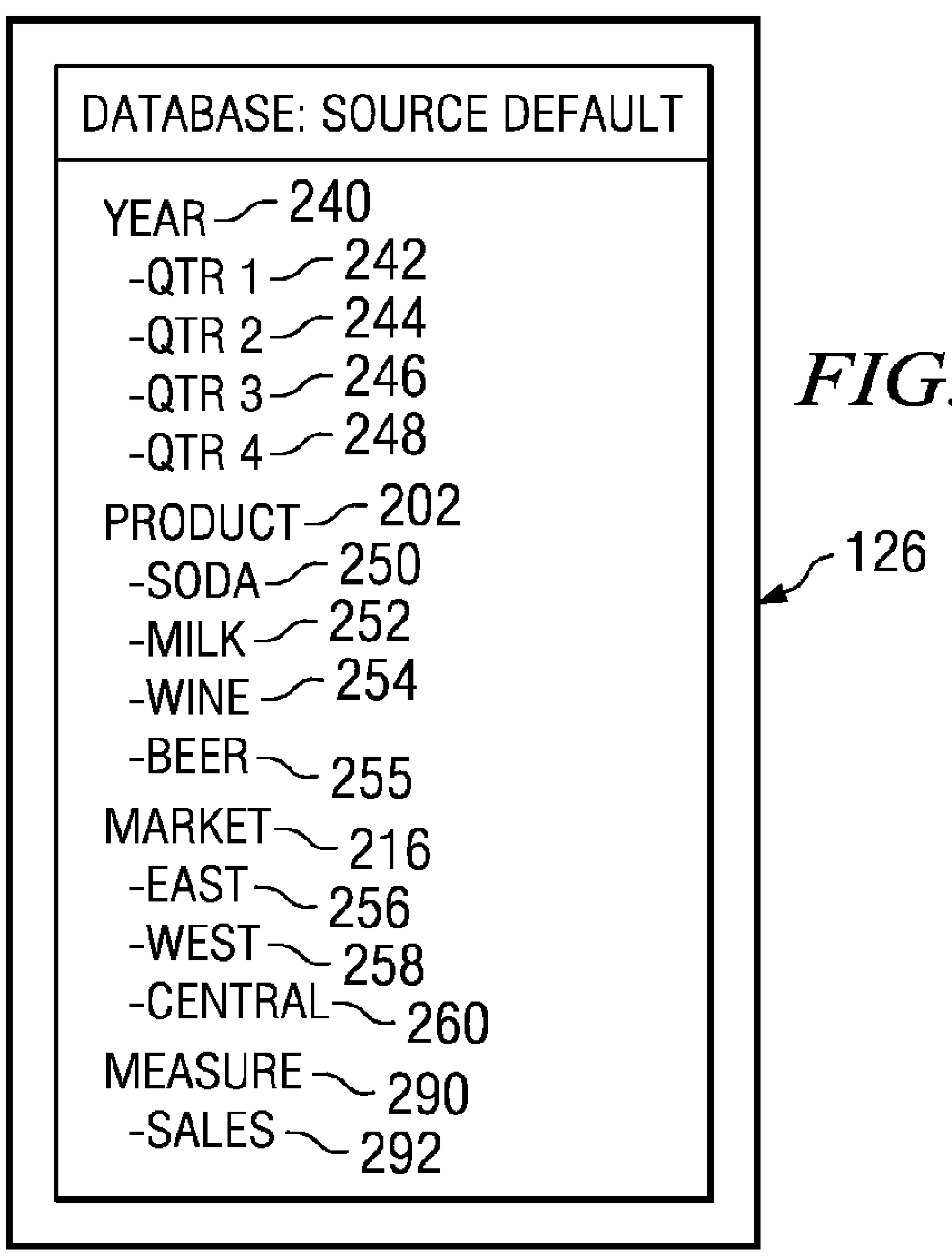
232
230
VIEW: i*k
234
VIEW: j*k

FIG. 2A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-WINE 254
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-WEST 258
-CENTRAL 260
MEASURE 290
-SALES 292
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FIG. 2B

FIG. 2C

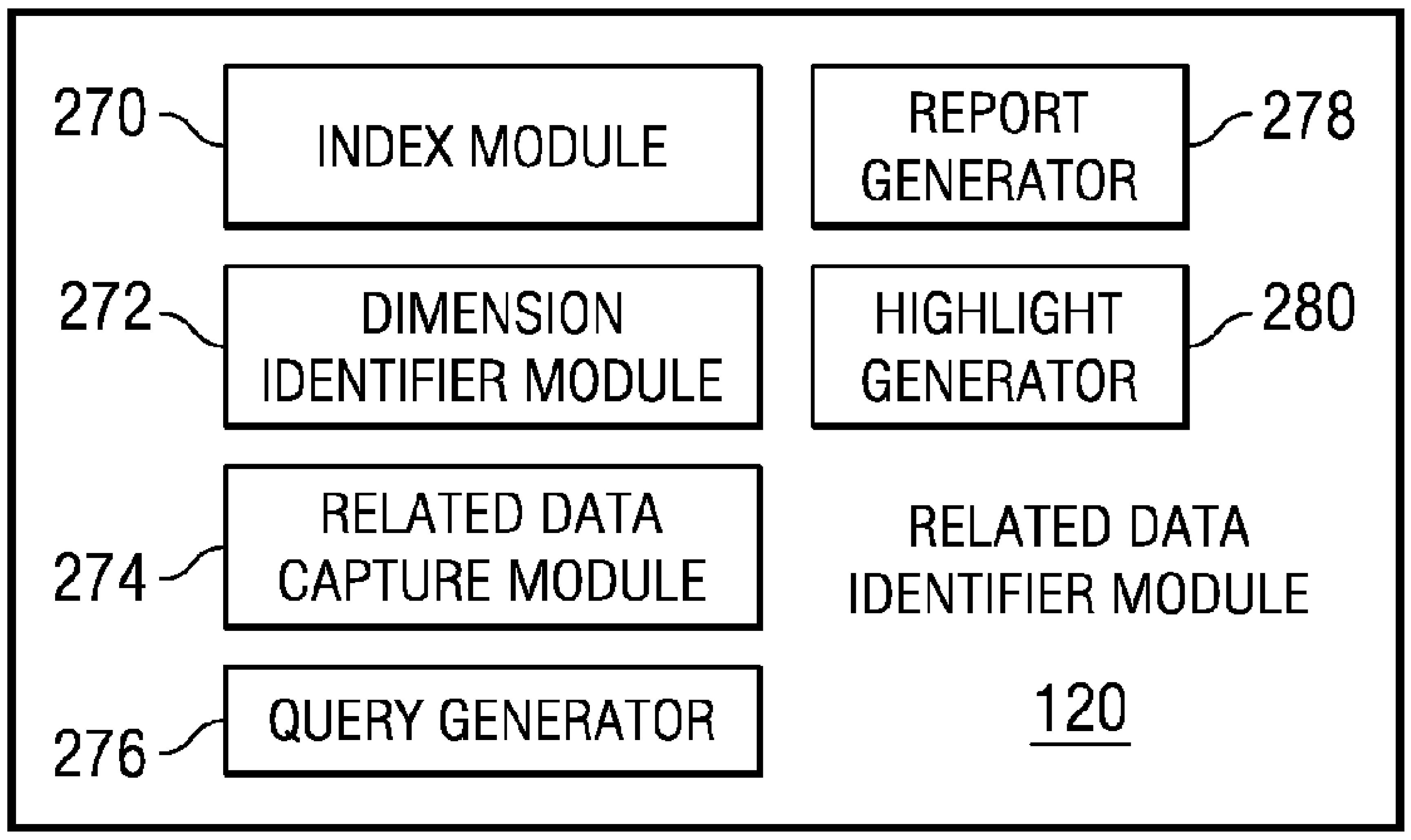


FIG. 3

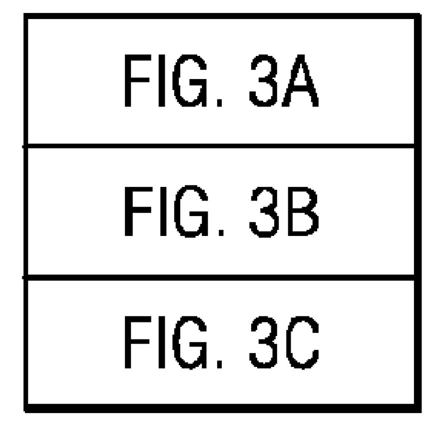


FIG. 3A

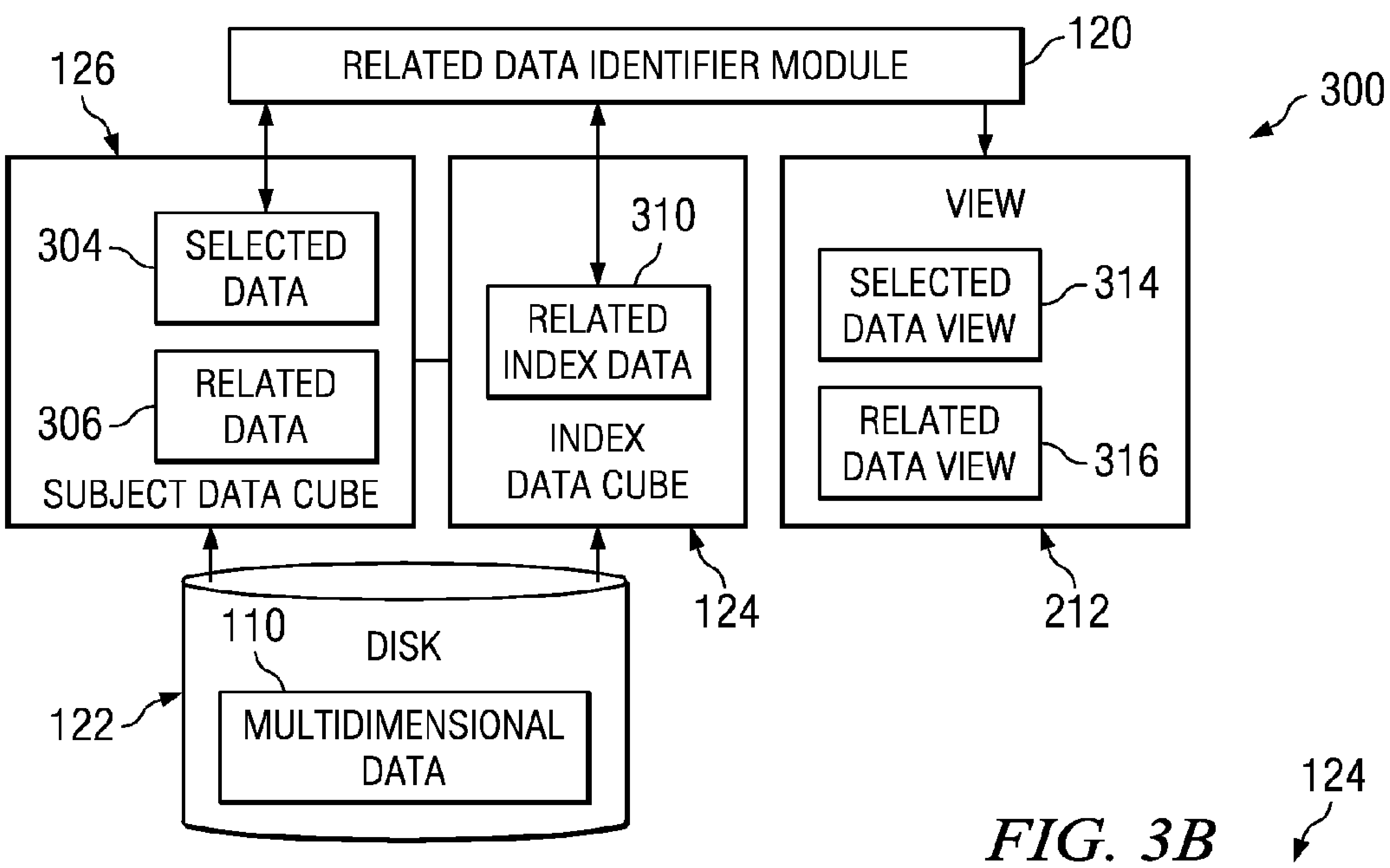


FIG. 3B

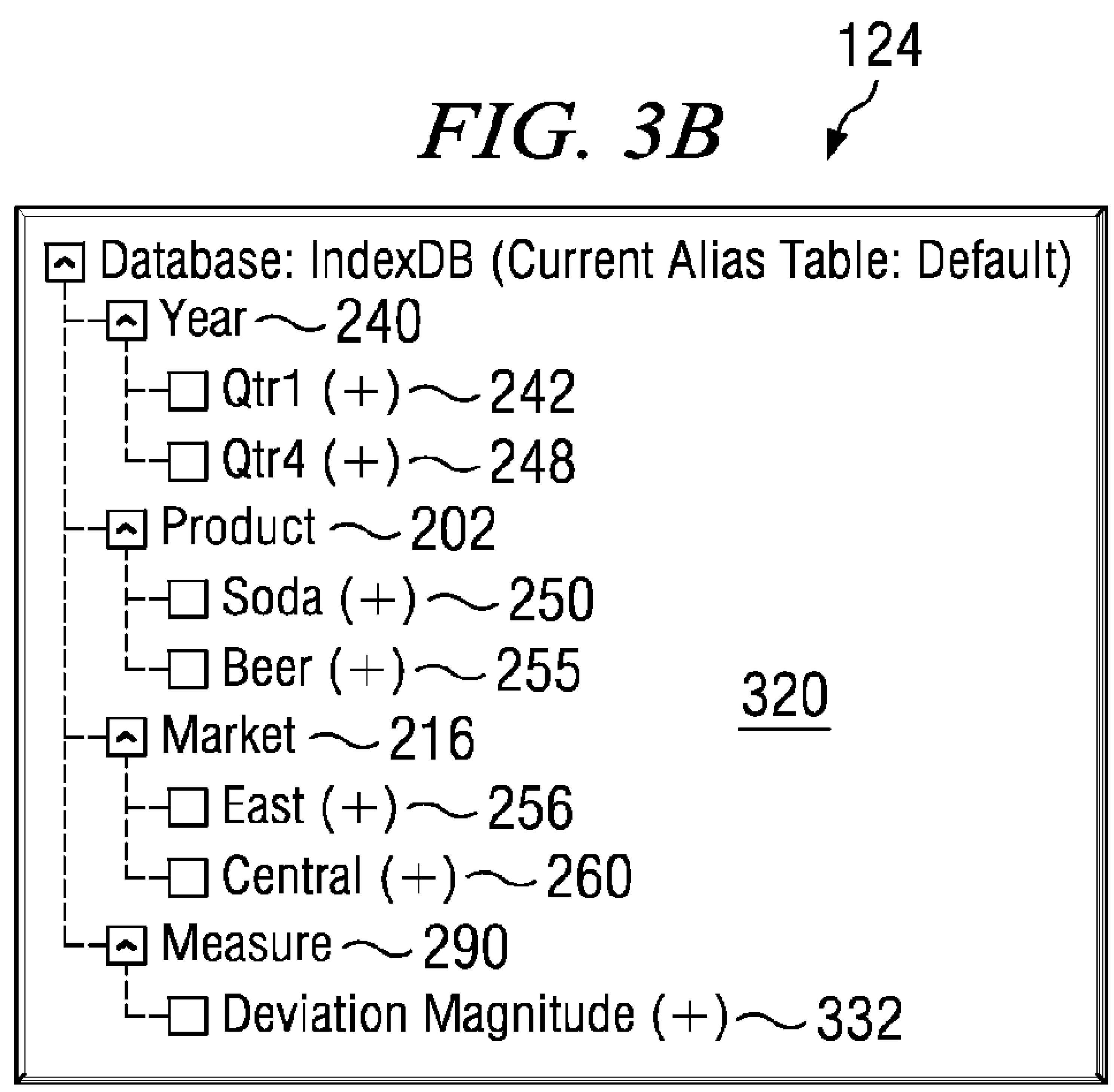


FIG. 3C

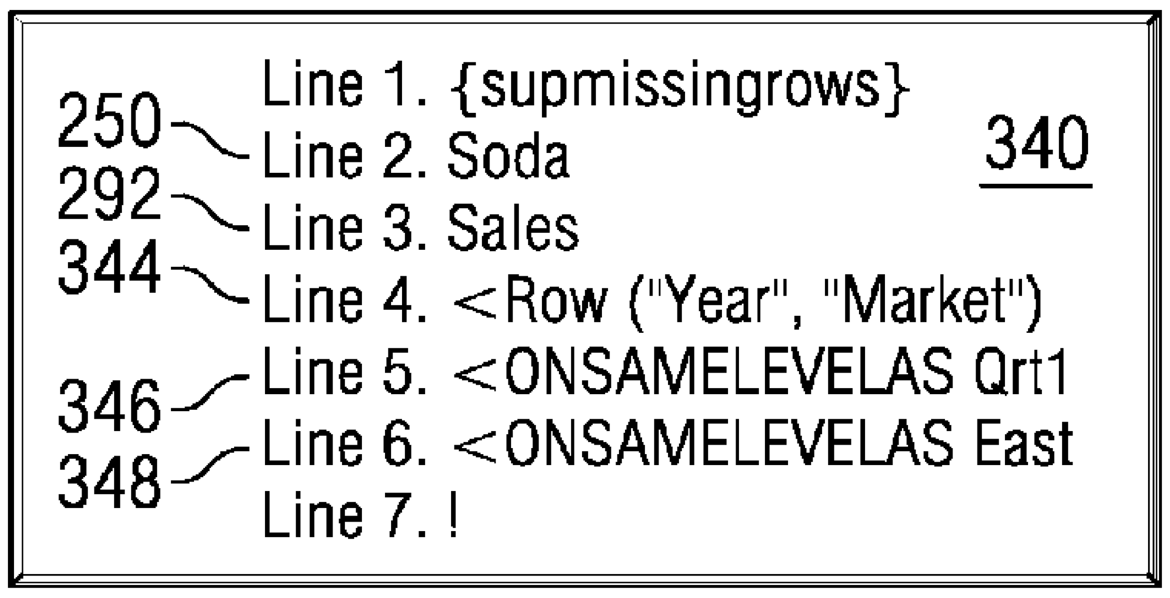


FIG. 4

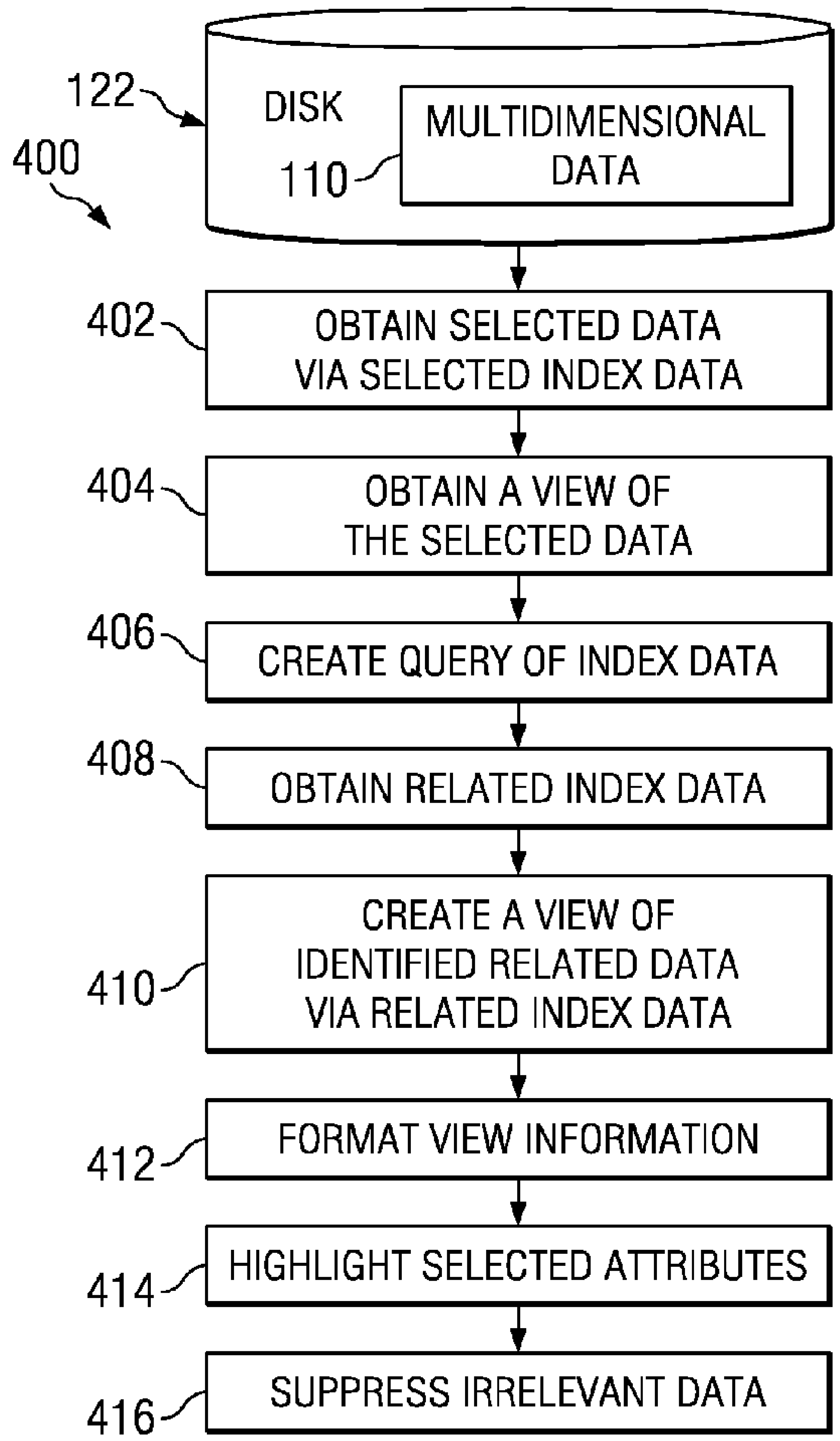
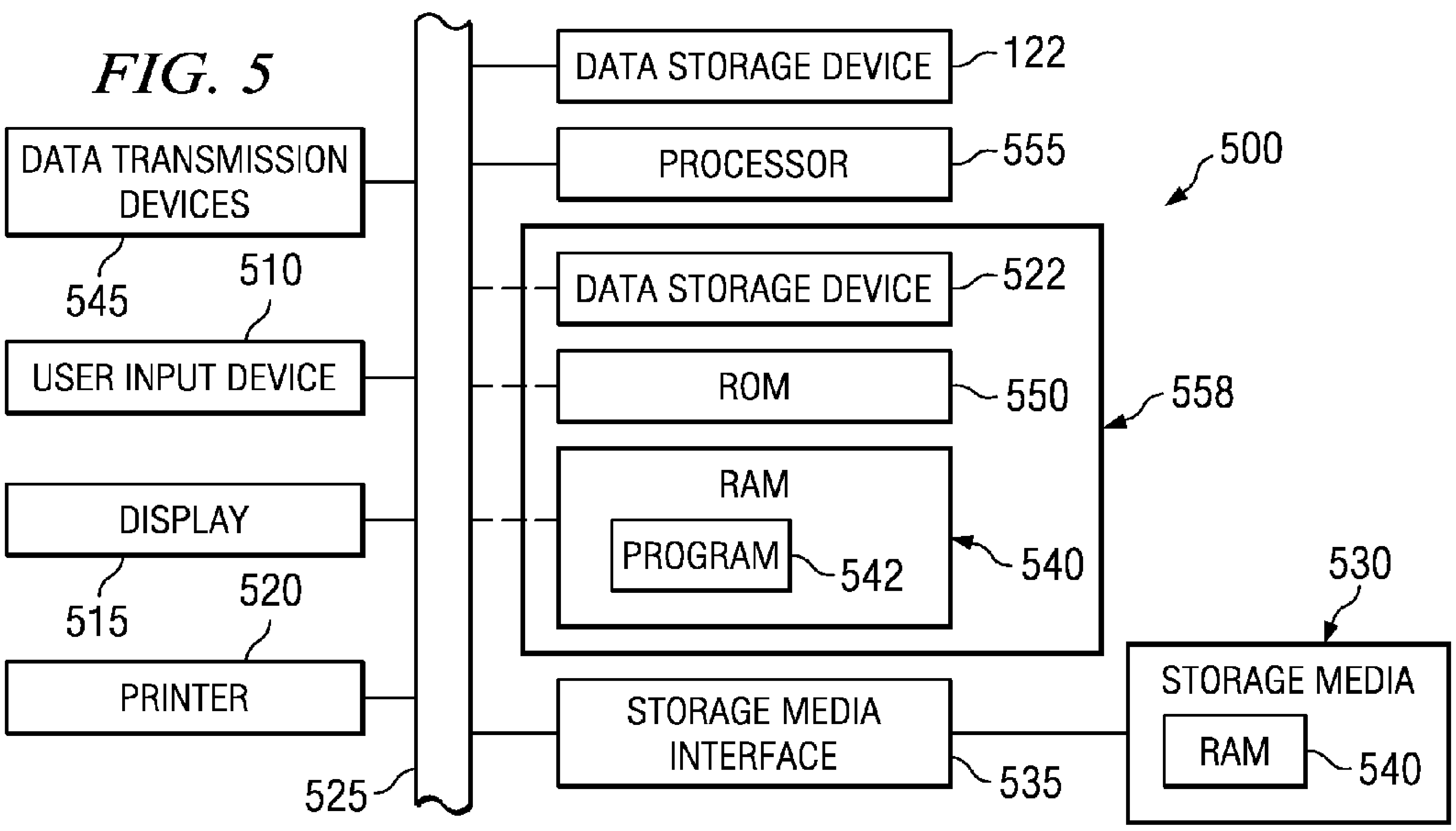


FIG. 5



SYSTEMS AND COMPUTER PROGRAM PRODUCTS TO IDENTIFY RELATED DATA IN A MULTIDIMENSIONAL DATABASE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of and claims the benefit of U.S. Pat. No. 7,472,127 B2 "SYSTEMS, METHODS, AND COMPUTER PROGRAM PRODUCTS TO IDENTIFY RELATED DATA IN A MULTIDIMENSIONAL DATABASE", having U.S. application Ser. No. 10/325,299, filed Dec. 18, 2002, the entire contents of which is incorporated herein by reference.

In co-pending U.S. application Ser. No. 09/565,132 entitled "Navigating an Index to Access a Subject Multi-Dimensional Database," by William Earl Malloy et. al, assigned to the assignee of the present invention, and incorporated herein in its entirety by this reference, there is described a method, apparatus, and article of manufacture for using an index to access a subject multidimensional database. Although not limited thereto, the present invention employs such a method in one of its preferred embodiments. U.S. application Ser. No. 09/565,132 issued as U.S. Pat. No. 7,269,786 on Sep. 11, 2007.

In co-pending U.S. application Ser. No. 09/564,344 entitled "Using an Index to Access A Subject Multi-Dimensional Database," by William Earl Malloy et. al, assigned to the assignee of the present invention, and incorporated herein in its entirety by this reference, there is described a method, apparatus, and article of manufacture for using an index to access a subject multidimensional database. Although not limited thereto, the present invention employs such a method in one of its preferred embodiments. U.S. application Ser. No. 09/564,344 issued as U.S. Pat. No. 6,915,289 on Jul. 5, 2005, and a Statutory Disclaimer was filed for U.S. Pat. No. 6,915,289 on Jan. 10, 2007. U.S. Pat. No. 7,529,727, having U.S. application Ser. No. 09/747,515, entitled "Using an Index to Access A Subject Multi-Dimensional Database," by William Earl Malloy et. al, with U.S. Publication Number 2001/0054034, is a continuation of U.S. application Ser. No. 09/564,344, and is incorporated herein in its entirety by this reference.

In co-pending U.S. patent application Ser. No. 09/998,955, "Systems, Methods, and Computer Program Products to Interpret, Explain, and Manipulate Exceptions in Multidimensional Data," by Kelkar et al., assigned to the assignee of the present invention, there is described a method, apparatus, and article of manufacture for interpreting, explaining, and manipulating exceptions in multidimensional data on a computer system. Although not limited thereto, the present invention employs such a method in one of its preferred embodiments. U.S. application Ser. No. 09/998,955 issued as U.S. Pat. No. 6,654,764 on Nov. 25, 2003, and a Statutory Disclaimer was filed for U.S. Pat. No. 6,654,764 on Jan. 10, 2007.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to the field of computer-based multidimensional data modeling. It is more particularly directed to identifying data that is related to selected data in a multidimensional database on a computer system.

2. Description of the Background Art

On-Line Analytical Processing (OLAP) is a computing technique for summarizing, consolidating, viewing, analyzing, applying formulae to, and synthesizing data according to multiple dimensions. OLAP software enables users, such as analysts, managers, and executives, to gain insight into performance of an enterprise through rapid access to a wide variety of data "views" or "dimensions" that are organized to reflect the multidimensional nature of the enterprise performance data. An increasingly popular data model for OLAP applications is the multidimensional database (MDDB), which is also known as the "data cube." OLAP data cubes are often used by a data analyst for interactive exploration of performance data. New opportunities associated with the enterprise may be discovered by identifying relationships and associations in the data.

OLAP functionality is characterized by dynamic multidimensional analysis of data supporting end user analytical and navigational activities including: calculation and modeling applied across dimensions through hierarchies or across members, trend analysis over sequential time periods, slicing subsets for on-screen viewing of the multidimensional data, drill-down to deeper levels of consolidation of the multidimensional data, reach-through to underlying detail data, and rotation to new dimensional comparisons in the viewing area associated with the multidimensional data. It is frequently difficult to efficiently analyze multidimensional data due to the lack of referential information about the association of the data to other neighboring and possibly related multidimensional data.

A multidimensional OLAP system typically has multiple dimensions and may have members within each dimension. A member may be considered a name of a category used in multidimensional analysis. That is, a member may be a label associated with an edge that edge being a dimension in a multidimensional data cube. For example, "March" could be a member that identifies information that was stored relating to the month of March. Such a system that supports a multidimensional data cube is often very large, and it may be difficult to identify where the most interesting features are in a vast pool of data. More particularly it is often difficult and time consuming to identify and analyze the most interesting features when the relationship and association between the data in a multidimensional data cube is unclear.

In order to facilitate access of information in a data cube, an index that may be represented in an index data cube and that references data in the data cube may be generated. The index may be used to access selected information in a data cube more efficiently than access techniques that do not employ an index. Given an index that is used to access and select particular multidimensional data, it would be useful to present the context in which the selected multidimensional data is located as a representation of neighboring or associated multidimensional data.

From the foregoing it will be apparent that there is still a need to improve OLAP data analysis by determining the relationship between selected multidimensional data and neighboring or associated multidimensional data on a computer system. More particularly, existing systems have not been able to adequately and efficiently determine the relationship between neighboring or associated data that may be configured in a database and that is associated with selected multidimensional data.

SUMMARY OF THE INVENTION

An embodiment of the present invention relates to systems, methods, and computer products that identify data that are related to selected data in a database on a computer system. The present invention is related to the field of computer-based multidimensional data modeling often used by data analysts.

The present invention assists the data analyst by efficiently identifying and more clearly presenting data that is related to or associated with selected multidimensional data such as selected data that is discussed with reference to U.S. patent application Ser. No. 09/565,132, "Navigating an Index to Access a Subject Multi-Dimensional Database." Existing systems have not been able to efficiently and adequately identify data that is related to, or associated with, selected data in a multidimensional database.

The preferred embodiment of the present invention operates efficiently with an index that includes location and magnitude information about features in a subject multidimensional database. More particularly, selected data has been extracted from the subject multidimensional database and the preferred embodiment of the present invention uses a Related Data Identifier Module to access information in the index that is used to identify data that is related to and associated with the selected data. The overwhelming amount of data in a multidimensional database that may be viewed by a user, such as a data analyst, is efficiently and advantageously reduced, by the preferred embodiment of the present invention, to the selected and related data.

The preferred embodiment of the present invention operates on features of selected data that may be presented in a two-dimensional view or multi-dimensional view, and enhances the view with associated data that may be uniquely formatted. The associated data is related to the selected data along the dimensions of the view that are used to present the selected data. Further, the preferred embodiment of the present invention may identify the associated data as sibling data of the selected data. The sibling data is at the same level of aggregation in the subject multidimensional database as the selected data. The preferred embodiment of the present invention novelly accesses the selected data by using index data that is not necessarily at the same hierarchy level and the index data is not necessarily represented as a multidimensional database.

An embodiment of the present invention is achieved by systems, methods, and articles of manufacture that use an index that identifies data that is related to selected data in a multidimensional database on a computer system. The method of the preferred embodiment of the present invention comprises: (a) obtaining selected data, typically from a subject multidimensional database by the use of index data; (b) creating a view of the selected data; (c) creating a query that accesses the index data to obtain related index data; and (d) obtaining a view of the identified related data via the use of the related index data. Further the method may comprise: (e) creating a view of the related data; (f) formatting the view of the related data and the selected data for presentation to a user; and (g) highlighting attributes of the related data and the selected data in the view based on highlighting criteria. One embodiment of the present invention may also suppress information about the selected data in the subject database that is not interesting, such as empty data points. This enables the user to view related data without the inclusion of irrelevant data.

Other aspects and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed description and in the several figures of the drawings, like elements are identified with like reference numerals.

FIG. **1** is a block diagram that illustrates the present invention;

FIG. **2**A is a block diagram of a multidimensional database, an OLAP data cube, that is suitably configured for operation with the present invention;

FIG. **2**B is a block diagram that illustrates the conceptual structure of a subject multidimensional database;

FIG. **2**C is a block diagram that illustrates the Related Data Identifier Module;

FIG. **3**A is a block diagram that illustrates the operation of the Related Data Identifier Module;

FIG. **3**B is a block diagram that illustrates the conceptual structure of an index multidimensional database;

FIG. **3**C is a block diagram that illustrates a query used to determine related data;

FIG. **4** is a flow diagram that illustrates the method of the present invention; and

FIG. **5** is a block diagram of a computer system suitably configured for employment of the present invention.

DESCRIPTION OF THE INVENTION

As shown in the drawings and for purposes of illustration, the preferred embodiment of the invention novelly identifies data that is related to and associated with data that has been selected from a multidimensional database. The overwhelming amount of data in a multidimensional database that may be viewed by a user, such as a data analyst, is reduced to the selected data that is presented along with multidimensional data that is related to and associated with selected data. According to the present invention, irrelevant data is filtered out and not presented to the user thereby providing a simplified view of the data for analysis. Existing systems have not been able to efficiently and adequately provide contextual information about selected data by identifying data that is related to and associated with selected data in a multidimensional database.

As shown in FIG. **1** and in element **100**, the preferred embodiment of the present invention may operate in a client-server computer system configuration. It will be appreciated that other computer system environments may be used to practice the present invention and the described computer system environment should not be considered limiting. Therefore, a client computer system **104** may communicate with a server computer system **102** during the operation of the present invention. The related Data Identifier Module **120** operates in either the client **104** or the server **102** to perform the preferred embodiment of the present invention. For example, information may be communicated to either the server **102** or the client **104** via the user interface **117**. Through such communication, data selection criteria **132** and data report highlight criteria **130** may be established and may subsequently be used by the Related Data Identifier Module **120** to manipulate data **108**, such as multidimensional data **110**. The user interface **117** may communicate with the preferred embodiment of the present invention, either via batch input **119** or user input **118**.

Further, an OLAP data cube **106** may be configured in the memory **558** of either the client **104** or the server **102**. Alternatively, the OLAP data cube **106** may be configured in computer storage such as a disk **122**. Typically, the OLAP data cube **106** is configured in computer storage of a disk **122** associated with the server **102**, and the client **104** typically accesses portions of the multidimensional data **110**. The terms "OLAP data cube," "data cube," and "multidimensional database" will be used interchangeably herein. Element **558** is described with reference to FIG. **5**.

The operation of the present invention uses a subject data cube **126** and an index data cube **124**. The subject data cube **126** is the multidimensional database **110** that is the subject of analysis by the user. The index data cube **124** is used to access selected data **304** in the subject data cube **126**. The index data cube **124** and the subject data cube **126** may be located in the memory **558** of a computer system **500** or on another computer media, such as the disk **122**. The preferred embodiment of the present invention novelly uses a data cube **106** to represent the index data cube **124** so that a multidimensional query may be used to determine the data **108** that is related to and associated with the information in the subject data cube **126**. Element **304** is described with reference to FIG. **3**, and element **500** is described with reference to FIG. **5**.

FIG. **2** includes FIG. **2**A, FIG. **2**B, and FIG. **2**C. As shown in FIG. **2**A, an OLAP data cube **106** is suitably configured for operation with the present invention. Therefore, by means of explanation, an example of the operation of the present invention is described. The view **212** that may be represented as a row or column may be included in an OLAP data cube **106**, and is organized to reflect the multidimensional nature of the enterprise performance data **108**. In the present invention views **212**, particularly two-dimensional views **212** that are used to view selected data **304** in context, are generated by selecting pairs of dimensions **213** from the subject data cube **126** and slicing the subject data cube **126** along those dimensions **213** so that the data point from the subject data cube **126** is included in the slice. For example, in the present example the three dimensions **213** are included in planes that are sliced by either a row or a column and create the following views **212**: view i*j, as shown in element **232**, view i*k, as shown in element **230**, and view j*k, as shown in element **234**. Elements **106**, **108**, and **126** are described with reference to FIG. **1**, and element **304** is described with reference to FIG. **3**.

Further, a dimension is a set or collection of related categorical elements, as defined by an analytic model. For example, all time periods in a fiscal calendar (including defined groups of periods such as weeks, months, quarters, and years) might form a Time Dimension **208**. In the same way all product identifiers (including groups of products) might form a Product Dimension **202**. Herein the Market Dimension **216** may be used to identify all product markets, such as East **256**, West **258**, and Central **260**.

A multidimensional data cube **106** typically includes data **108** in a hierarchical structure that may be represented as aggregated levels. In the present example, the actual name of the Time dimension **208** is Year **240**. The Year dimension **240** may be decomposed into levels. In the present example the Time dimension **208** includes a quarter level with: Qtr **1**, as shown in element **242**, Qtr **2**, as shown in element **244**, Qtr **3**, as shown in element **246**, and Qtr **4**, as shown in element **248** that are siblings with respect to the hierarchical structure represented. The Product dimension **202** may be decomposed into information about the following products: Soda **250**, Milk **252**, and Wine **254**.

FIG. **2**B is a block diagram that illustrates the conceptual structure of a subject multidimensional database **126**. Therefore, by means of example the subject multidimensional database **126** includes information about the Year **240**, Products **202**, and Market **216**. The information may be organized in a hierarchical fashion. Therefore the information about a Year **240** may include information about quarters such as: Qtr **1** as shown in element **242**, Qtr **2** as shown in element **244**, Qtr **3** as shown in element **246**, and Qtr **4** as shown in element **248**. Information at the same hierarchy level may also be presented for Product data **202** and Market data **216**. The Product data **202** may include information about: Soda **250**, Milk **252**, Wine **254**, and Beer **255**. The Market information **216** may include information about: the East **256** market, the West **258** market, and the Central **260** market. The subject database **126** often includes a Measures Dimension **290** that enumerates the quantities that are stored in the multidimensional database **110**, such as Profit, Income, Expense, and Inventory. In the present example, the Measures Dimension **290** has a single member, Sales **292**.

As shown in FIG. **2**C, the Related Data Identifier Module **120** includes elements used in the preferred embodiment of the present invention. The Related Data Identifier Module **120** is typically program code that may be embodied as a computer program **542** (as shown in FIG. **5**), and by means of example an embodiment of the Related Data Identifier Module **120** is described in U.S. patent application Ser. No. 09/565,132, "Navigating an Index to Access a Subject Multi-Dimensional Database." The Index Module **270** is used by an embodiment of the present invention to determine an index that is used to access the subject data cube **126**. The preferred embodiment of the present invention creates the index data cube **124** that is used to access the subject data cube **126**. Elements **124** and **126** are described with reference to FIG. **1**.

The Dimension Identifier Module **272** is used to identify selected data **304** that is represented as dimensions **213** for a preferred projection of multidimensional data **110**, such as is described in U.S. patent application Ser. No. 09/998,955, "Systems, Methods, and Computer Program Products To Interpret, Explain, and Manipulate Exceptions in Multidimensional Data." The related Data Capture Module **274** is used to access the index data cube **124** and identify related data **306** that is associated with the selected data **304** by use of the related index data **310**. The Query Generator **276** is used to generate a query that is executed against the index data cube **124** to determine the related index data **310**. The Report Generator **278** is used to generate a report of the selected data **304** and the related data **306**. Such a report is shown in Table 6 herein. Further, the Highlight Generator **280** is used to highlight certain attributes of the selected data **304** and related data **306** that meet highlight criteria **130**. Elements **110** and **130** are described with reference to FIG. **1**, element **213** is described with reference to FIG. **2**A, and elements **304**, **306**, and **310** are described with reference to FIG. **3**.

FIG. **3** includes FIG. **3**A, FIG. **3**B, and FIG. **3**C. FIG. **3**A, as shown in element **300**, illustrates the novel operation of the Related Data Identifier Module **120**. The Related Data Identifier Module **120** obtains selected data **304** from a subject data cube **126**. The subject data cube **126** is created from multidimensional data **110** that is typically stored on a disk **122**. Element **212** is described with reference to FIG. **2**.

The Related Data Identifier Module **120** novelly operates according to the present invention by performing multidimensional queries on the index data cube **124** in order to identify related index data **310**. Since the index data cube **124** is typically sparse, identifying related index data **310** by the use of multidimensional queries is an efficient way of identifying, in a single operation, all selected data **304** in a given view **212** of the subject data cube **126** that is referenced by the index data **124**. Therefore, and in the preferred embodiment of the present invention, the index data cube **124** is represented as a multidimensional cube **106** so that the multidimensional queries directed to the index data cube **124** may be performed efficiently. Further, the members of identified selected data **304** determine the predicate or predicates of the multidimensional queries. Therefore, the Related Data Identifier Module **120** may novelly identify related data **306** that is associated with the selected data **304** by use of multidimensional queries directed to the related index data **310**. Further the selected data **304** and the related data **306** may be presented to the user in a view **212**, such as a selected data view **314** and a related data view **316**.

FIG. **3**B, as shown in element **124**, illustrates the conceptual structure of the index data cube **124**. In one embodiment of the present invention, a system is based on the product marketed under the trademark Hyperion® Essbase® OLAP software. The present invention utilizes a number of components from the Essbase® OLAP system, including the outline illustrated herein. However, since the present invention comprises new elements that enable identification of related data **306** that is associated with selected data **304** that has been selected from a multidimensional database **110**, those skilled in the art will recognize that the present invention may be practiced without components based on Hyperion® Essbase® OLAP software. For example, there are a number of multidimensional systems that use Multidimensional Expressions (MDX) as their query language. Element **110** is described with reference to FIG. **1**, and elements **304** and **306** are described with reference to FIG. **3**A.

In the present example, the multidimensional structure of the index data cube **124** may be represented as an outline, as shown in element **320**. The Measures Dimension **290** has only a single member, Deviation Magnitude **332**. The index data cube **124** identifies cells that fall within particular thresholds that are applied to the data in the subject database **126**. Further, as shown in Table 1, the present example of the index data cube **124** includes information about the values of Sales **292** having Deviation Magnitudes **332** at or above eight. Therefore in the present example the Products **202** shown are: Soda as shown in element **250**, and Beer as shown in element **255**. The Deviation Magnitudes **332** shown in Table 1 represent the deviations from the mean for the identified Sales **292** figures and serve to standardize the information that is presented. Element **126** is described with reference to FIG. **1**, and element **272** is described with reference to FIG. **2**.

It will be appreciated by those skilled in the art that there are many methods of calculating a deviation magnitude **332** associated with data **108** in the multidimensional data cube **110**. Such a method is described in U.S. Pat. No. 6,094,651, "Discovery-Driven Exploration of OLAP Data Cubes." Other index data cubes **124** in the present example that are associated with the Market data **214** are East as shown in element **256** and Central as shown in element **260**. Element **108** is described with reference to FIG. **1**.

TABLE 1

Index Data:

Measure	Year	Product	Market	Deviation Magnitude
Sales	Qtr 1	Soda	East	11
Sales	Qtr 1	Soda	Central	9
Sales	Qtr 4	Soda	Central	9
Sales	Qtr 1	Beer	Central	9
Sales	Qtr 4	Beer	East	8

Given the index data cube **124** illustrated in FIG. **3**B, further information about a particular row may be obtained by operation of the present invention. For example, the feature shown in Table 2, is an example of related index data **310** that is discussed with reference to FIG. **3**A. Therefore in this example, the related index data **310** of Table 2 may drive the operation of the present invention.

TABLE 2

Related Index Data:

Measure	Year	Product	Market	Deviation Magnitude
Sales	Qtr 1	Soda	East	11

As shown in Table 3, subject data **304** is used to present related data **306** that is located by use of information in the related index **310**. Therefore, as shown in Table 3, Sales **292** data about Soda **250** in all Markets **216** and for all quarters in the Year **240** is described.

TABLE 3

Related Data - Sales Figures:

Sales	Soda East	West	Central
Qtr 1	−9.32	1.20	20.6
Qtr 2	1.34	1.32	1.56
Qtr 3	1.60	1.34	1.21
Qtr 4	1.81	1.10	30.4

Continuing with the current example, the information associated with three entries in Table 3 falls within a threshold, such as highlight criteria **130**, that may be set by the user. It may be understood that the highlight criteria **130** enables the user or an administrator to constrain the points that are highlighted for any purpose, such as security or specialized analysis. Therefore, since the data shown in Table 4 falls within a threshold it represents related data **306** with Sales **292** figures of interest. The fact that the data for East **256** in Qtr **1 242** falls within the identified threshold is not a surprise because the view of data in Table 3 was driven by the selection of the index entry shown in Table 3. However, with very large subject data cubes **126** and complex methods for determining which features to include in the index data cube **124**, it may not be apparent that the Sales **292** figures in the last two rows of Table 4 also fall within the identified threshold specified in the creation of the index data cube **124**. Element **130** is described with reference to FIG. **1**.

TABLE 4

Significant Sales Figures:

Sales	Qtr 1	Soda	East	−9.32
Sales	Qtr 1	Soda	Central	20.6
Sales	Qtr 4	Soda	Central	30.4

Now, as shown in FIG. **3**C and element **340**, a query of the index data cube **124** is performed according to the preferred embodiment of the present invention. The Essbase® report script language query is shown in FIG. **3**C. However, it will be appreciated by those skilled in the art that the present invention may be practiced with components based on multidimensional software other than Hyperion® Essbase® OLAP software. The example query fixes on non-expanded members of the related data **306**, namely Soda **250** and Sales **392**, as shown in lines **2** and **3**. The other two dimensions **213**, Year **240** and Market **216** are chosen to generate the view **212** and as shown in element **344** the report script declares these two dimensions **213** as row labels in line **4**. The present example shows that a dimension **213** is novelly used by the present invention to create a representation of selected data **304** and related data **306**. For each selected dimension **213**, a representative set of siblings (members of the same level) of the member that identifies the selected data **304** within that dimension **213**, are used to retrieve related data **306**. By means of further explanation, the related data **306** are retrieved by accessing combinations of members that are at the same level of aggregation, in the hierarchies of the Subject Data Cube **126** as the Selected Data **304**. For example sibling members include Qtr **4** as shown in element **248**, and Central as shown in element **260**, respectively. In the present example, the sibling members are obtained by use of the directives shown in elements **346** and **348**, and are further shown with reference to Table 6. Since the index data cube **124** contains only indexed features of the subject database **126** the result is highly sparse and the query operation is highly efficient. The query **340** result of the search of the index data cube **124**, the related index data **310**, is shown in Table 5. Notice that the data points that are not interesting, such as empty data points, have been suppressed in the reporting of the indexed features of the subject database **126**. Elements **110**, **124**, and **126** are described with reference to FIG. **1**; elements **202**, **204**, **212**, **213**, **216**, **234**, **240**, **248** and **250** are described with reference to FIG. **2**; elements **304**, **306**, and **310** are described with reference to FIG. **3**A; and element **340** is described with reference to FIG. **3**C.

TABLE 5

Query Result:				
Soda	Sales	Qtr 1	East	11
Soda	Sales	Qtr 1	Central	9
Soda	Sales	Qtr 4	Central	9

The view **212** of the subject database **126** is now augmented by the preferred embodiment of the present invention by highlighting the features identified by the query. The resulting view **212** of the subject database **126** shows the selected data **304** in context with other multidimensional data **110** at the same level of aggregation. Further, related data **306** are identified by use of the related index data **310** and in the present example the related data **306** in the related data view **316** are shown in bold format. The selected data point **304** is shown within a selected data view **314** in both bold and underlined format. Therefore, the selected data **304** and the related data **306** may be formatted and presented to the user in one highlighted view **212**, as shown in Table 6. While the present example has included two-dimensional views **212**, the operation of the present invention is not limited to two-dimensional views **212** and may operate with multi-dimensional views **212**. Elements **314** and **316** are described with reference to FIG. **3**A

TABLE 6

Highlighted View:

Sales	Soda East	West	Central
Qtr 1	−9.32	1.20	20.6
Qtr 2	1.34	1.32	1.56
Qtr 3	1.60	1.34	1.21
Qtr 4	1.81	1.10	30.4

FIG. **4** and element **400** illustrate the preferred method of the present invention that identifies data that are related to selected data **304** in a multidimensional database **110** on a computer system **500**. The method of the preferred embodiment of the present invention comprises obtaining selected data **304**, typically from a subject multidimensional database **126**, as shown in element **402**. The selected data **304** is obtained via the use of the index data cube **124**. As shown in element **404**, a view of the selected data **314** is obtained. A query of the index data cube **124** is created, as shown in element **406**, and as shown in element **408**, the query accesses the index data cube **124** to obtain related index data **310**. As shown in element **410**, a view of the identified related data **316** is obtained via the use of the related index data **310**. Elements **124** and **126** are described with reference to FIG. **1**, elements **304**, **306**, **310**, **314**, and **316** are described with reference to FIG. **3**, and element **500** is are described with reference to FIG. **5**.

Further, the view of the related data **316** and the selected data **314** may be formatted for presentation to a user, as shown in element **412**. The attributes of the related data **306** and the selected data **304** that meet the threshold set by highlight criteria **130** may be highlighted, as shown in element **414**. As shown in element **416**, the preferred embodiment of the present invention may also suppress irrelevant data **108** that exists in the subject database **126** that might otherwise be included as part of a view **212** showing selected data **304** in context. Elements **108** and **130** are described with reference to FIG. **1**, and element **212** is described with reference to FIG. **2**.

FIG. **5** is a block diagram of a computer system **500**, suitable for employment of the present invention. System **500** may be implemented on a general-purpose microcomputer, such as one of the members of the IBM Personal Computer family, or other conventional workstation or graphics computer devices, or mainframe computers. In its preferred embodiment, system **500** includes a user input device **510**, a display **515**, a printer **520**, a processor **555**, a read only memory (ROM) **550**, a data storage device **122**, such as a hard drive, a random access memory (RAM) **540**, and a storage media interface **535**, all of which are coupled to a bus **525** or other communication means for communicating information. Although system **500** is represented herein as a standalone system, it is not limited to such, but instead can be part of a networked system. For example, the computer system **500** may be connected locally or remotely to fixed or removable data storage devices **122** and data transmission devices **545**. Further, the computer system **500**, such as the server computer system **102** and the client computer system **104**, also could be connected to other computer systems **500** via the data transmission devices **545**. Elements **102** and **104** are described with reference to FIG. **1**.

The RAM **540**, the data storage device **122**, and the ROM **550**, are memory components **558** that store data **108** and instructions for controlling the operation of processor **555**, which may be configured as a single processor or as a plurality of processors. The processor **555** executes a program **542** to perform the methods of the present invention, as described herein. Element **108** is described with reference to FIG. **1**.

While the program **542** is indicated as loaded into the RAM **540**, it may be configured on a storage media **530** for subsequent loading into the data storage device **122**, the ROM **550**, or the RAM **540** via an appropriate storage media interface **535**. Storage media **530** can be any conventional storage media such as a magnetic tape, an optical storage media, a compact disk, or a floppy disk. Alternatively, storage media **530** can be a random access memory **540**, or other type of electronic storage, located on a remote storage system.

Generally, the computer programs and operating systems are all tangibly embodied in a computer-readable device or media, such as the memory **558**, the data storage device **122**, or the data transmission device **545**, thereby making an article of manufacture, such as a computer program product, according to the invention. As such, the terms "computer program product" as used herein are intended to encompass a computer program **542** accessible from any computer readable device or media.

Moreover, the computer programs **542** and operating systems are comprised of instructions which, when read and executed by the computer system **500**, such as the server computer system **102** and the client computer system **104**, cause the computer system **500**, such as the server computer system **102** and the client computer system **104**, to perform the steps necessary to implement and use the present invention. Under control of the operating system, the computer programs **542** may be loaded from the memory **558**, the data storage device **122**, or the data transmission devices **545** into the memories **558** of the computer system **500**, such as the server computer system **102** and the client computer system **104**, for use during actual operations. Those skilled in the art will recognize many modifications may be made to this configuration without departing from the scope of the present invention. Elements **102** and **104** are described with reference to FIG. **1**.

The user input device **510**, such as a keyboard or speech recognition subsystem, enables a user to communicate information and command selections to the processor **555**. The user can observe information generated by the system **500** via the display **515** or the printer **520**. The user input device **510** may also be a device such as a mouse, track-ball, or joy-stick, which allows the user to manipulate a cursor on the display **515** for communicating additional information and command selections to the processor **555**.

When operating in accordance with one embodiment of the present invention, the system **500** identifies data **108** that is related to and associated with data **108** that has been selected from a multidimensional database **110**, by the use of an index that includes location and magnitude information about features in a subject multidimensional database. The processor **555** and the program **542** collectively operate as a module for identification of data **108** that is related to and associated with data **108** that has been selected from a multidimensional data **110** by the use of an index. The overwhelming amount of data **108** in a multidimensional database **110** is efficiently and advantageously reduced by the preferred embodiment of the present invention to the selected and related data. It will be appreciated that the present invention offers many advantages over prior art techniques. Elements **108** and **110** are described with reference to FIG. **1**.

The present invention is typically implemented using one or more computer programs **542**, each of which executes under the control of an operating system and causes the computer system **500**, such as the server computer system **102** and the client computer system **104**, to perform the desired functions as described herein. Thus, using the present specification, the invention may be implemented as a machine, process, method, system, or article of manufacture by using standard programming and engineering techniques to produce software, firmware, hardware or any combination thereof.

It should be understood that various alternatives and modifications can be devised by those skilled in the art. However, these should not be viewed as limitations upon the practice of these teachings, as those skilled in the art, when guided by the foregoing teachings, may derive other suitable characteristics of a similar or different nature. The present invention is intended to embrace all such alternatives, modifications and variances that fall within the scope of the appended claims

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What is claimed is:

1. A computer system for identifying related data that is associated with selected data said selected data that is implemented in a subject multidimensional database, said selected data being obtained by use of index data that is implemented in an index multidimensional database that is a data cube, comprising:

related index data that is identified from said index data by creating a multidimensional query and executing said multidimensional query against said index data, wherein said multidimensional query includes one or more predicates determined by members of said selected data;

said related data that is identified from said selected data by use of multidimensional queries directed to said related index data, wherein said related data is related to said selected data along dimensions of a view that is used to present said selected data to a user, and wherein identifying said related data includes retrieving said related data by accessing combinations of members that are at a same level of aggregation as members of said selected data;

said view of said selected data that is formatted for presentation to a user by:

determining highlighting criteria for said selected data; and

highlighting said selected data in said view that is used to present said selected data based on said highlighting criteria;

a view of said related data that is formatted for presentation to a user by:

determining highlighting criteria for said related data; and

highlighting said related data in said view that is used to present said related data to a user based on said highlighting criteria; and

said related data and said selected data presented to a user in one highlighted view.

2. The computer system of claim **1**, further comprising:

said view of said selected data that is created;

said multidimensional query that is created by use of said view of selected data; and

said related data that is identified by said multidimensional query that is directed to said index multidimensional database.

3. The computer system of claim **1**, further comprising a view of said related data that is created.

4. An article of manufacture comprising a computer-readable device storing instructions for identifying related data that is associated with selected data, said selected data that is implemented in a subject multidimensional database, said selected data being obtained by use of index data that is implemented in an index multidimensional database that is a data cube, wherein the instructions, when executed by a processor of a computer system, perform:

identifying related index data from said index data by creating a multidimensional query and executing said multidimensional query against said index data, wherein said multidimensional query includes one or more predicates determined by members of said selected data;

identifying said related data from said selected data by use of multidimensional queries directed to said related index data, wherein said related data is related to said selected data along dimensions of a view that is used to present said selected data to a user, and wherein identifying said related data includes retrieving said related data by accessing combinations of members that are at a same level of aggregation as members of said selected data;

formatting said view of said selected data for presentation to a user by:

determining highlighting criteria for said selected data;

highlighting said selected data in said view that is used to present said selected data based on said highlighting criteria;

formatting a view of said related data for presentation to a user by:

determining highlighting criteria for said related data; and

highlighting said related data in said view that is used to present said related data to a user based on said highlighting criteria; and

presenting said related data and said selected data to a user in one highlighted view.

5. The article of manufacture of claim **4**, further comprising:

creating said view of said selected data;

creating said multidimensional query by use of said view of selected data; and

identifying said related data by said multidimensional query that is directed to said index multidimensional database.

6. The article of manufacture of claim **4**, further comprising creating a view of said related data.

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